

V. *An Experiment to shew that the Friction of the several Parts in a Compound Engine, may be reduced to Calculation ; by drawing Consequences from some of the Experiments shewn before the Royal Society last Year, upon simple Machines, in various Circumstances, by me. Now exemplified by the Friction in a Combination of Pullies. By J.T. Desaguliers. Jan. 14, 1731.*

THE Machine consists of three Pullies (two upper and one lower, or a Tackle of Three) whose Diameters are exactly as follows, 2 Inches, $1\frac{1}{2}$ Inch, $1\frac{1}{4}$ Inch ; and all the Center Pins of $\frac{3}{4}$ Inch Diameter : The Rope being of $\frac{1}{10}$ Inch in Diameter.

The Weight is 18 Pounds *Averdupois*, and consequently the Power to keep it in *Æquilibrio* must be = 6 lb, and a very little more must make the Power raise the Weight, if there was no Friction ; but here no less than 20 Ounces are required, though the Machine is as nicely made as it can possibly be.

I have shewn by Experiment, that when the Weight is unknown, $\frac{2}{3}$ of the Power is the Friction of a Cylinder whose Surface moves as fast as the Power, and whose Gudgeons are equal in Diameter to the Cylinder. Now as the Diameter of the first Pulley is eight times bigger than its Pin, its Friction must be $\frac{4\text{ lb}}{8}$ or 8 Ounces.

The second Pulley, whose Surface. moves as slow again as the Power, and whose Pin is six times less
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Diameter must of Consequence have its Friction of only $5\frac{1}{2}$ Ounces; because $\frac{64\frac{2}{3}}{2} = 5\frac{1}{3}\frac{2}{3}$

The third Pulley moving with $\frac{1}{3}$ of the Velocity of the Power, on a Pin of $\frac{1}{4}$ of its Diameter, has for its Friction $4\frac{1}{3} - \frac{2}{3}$; because $\frac{64\frac{2}{3}}{3} = 4\frac{1}{3} - \frac{2}{3}$

Now the Sum of all these Frictions being 17,6 $\frac{2}{3}$ which is the 5,4 Part of the Power 6 lb, this Addition does so encrease the Friction as to require a Super-addition of the 5,4 Part of that first Addition, and so on, in this Series, $\frac{2}{3} 17,62 + 3,2 + 0,59, \&c. = 21,41\frac{2}{3}$.

Then the Sum of the Frictions upon account of bending the Ropes (too tedious to explain now, before I give a full Account in my intended Theory of Friction) deduced from the Experiment that a Rope of $\frac{1}{10}$ Inch in Diameter stretched by 6 lb requires 4,5 $\frac{2}{3}$ to bend it round a Cylinder of 1 Inch ———, amounts to $1,8 + 1,15 + 1,124 = 4,424\frac{2}{3}$, which, with the other Friction, amounts to 25,834 $\frac{2}{3}$. But as I have formerly shewn in these *Transactions*, that when a Rope drawn by unequal Weight runs over a Pulley, the Pressure on the Pin is diminished; that diminished Pressure (found by Calculation to be near 6 $\frac{2}{3}$) being taken from the above Sum, the Friction remaining will be 19,834 $\frac{2}{3}$; and the Experiment is just 20 $\frac{2}{3}$.

N. B. Nothing was here allowed for the Weight added to bend the Ropes, which would still bring the Experiment nearer the Theory.